Chapter 1 Understanding NASIS

What is NASIS?

The National Soil Information System (NASIS) is a generic software tool for managing data in a relational database system. The data NASIS manages are defined in a data dictionary that includes information about a particular business area, its policies, and procedures. The current NASIS data dictionary contains information about the soil survey database. New sections address site-specific information such as plant or soil profile descriptions.

Major Areas of NASIS

NASIS will eventually encompass the four major areas of soil survey plus operations and maintenance. Soil survey operations comprise an interaction of spatial data, map unit attributes, point or site attributes, and concept or aggregation criteria. Early releases of NASIS addressed the map unit attributes. Currently, NASIS includes objects and tables for database management, map unit attributes, and site and point attributes. NASIS uses a consistent interface throughout each of its areas.

Map unit attributes

NASIS allows entry and maintenance of map unit data. Differences between the representation of map unit attributes in SSSD and NASIS are extensively documented in this chapter, tutorial lessons, and the online help system.

Point and site attributes

NASIS incorporates site, pedon, and site association objects, each with several tables for management of point and site attributes. Lessons in chapters 18 and 19 focus specifically on the site and point attributes.

Concept and aggregation criteria

Long term plans include incorporation of principles and rules of soil survey operation into NASIS. Currently, tools within NASIS support application of principles and rules by soil survey personnel, though they are not the concept and aggregation criteria envisioned for later releases of NASIS. Existing tools provide calculated data elements, data validation, stored interpretations, interpretation generation capability, and choice lists for consistent selections.

Spatial data

Long term plans include the addition of spatial data to the NASIS database. Spatial data would include points on maps and polygons on maps.

NASIS Capabilities

The NASIS software provides generic tools and functionality for editing data, querying the NASIS database, generating reports, creating custom reports, and exporting data. With NASIS, you can calculate several data elements, such as taxonomic classifications.

NASIS also validates the completeness and integrity of the data. Underlying it all, NASIS provides functionality for managing the ownership and security of data.

Another powerful tool is the full-featured online help system. It offers keyword and full-text search capabilities, hypertext links, navigation tools, print capabilities, and more than four thousand help topics. As new objects, tables, or even major areas are added to NASIS, the online help system is expanded. The online help system fully integrates with the NASIS software and includes context-sensitive help for each table, column, and dialog box in NASIS.

Management of soil survey data

Presently, soil scientists use NASIS to create seamless soil surveys and coordinated MLRA legends. They correlate map units in ongoing surveys and join map units between survey areas. They generate documented soil interpretation results based on calculations performed automatically by NASIS. Moreover, they have the capability of creating their own interpretation criteria. Soil scientists use NASIS to generate standard soils reports and create specialized reports for manuscript publication. Finally, NASIS provides the capability of exporting data into the existing FOCS and SSURGO formats.

Table 1-1 lists the principal features of the NASIS software.

NASIS Software Features	
Centralized database and server for data sharing	Ability to select records from multiple tables in a single process
Specialized queries for finding specific information in the database	Report manager for developing reports
Find function for searching columns and tables	Query editor for developing custom queries
Choice lists for data selection	A setup editor for customizing display of columns within the individual tables
Access choice list descriptions	*HyperHelp Xprinter* for printing standard and custom reports and online help topics
Cut, copy, and paste editing tools	Ability to calculate data elements
Global editing functions	Data validations for checking completeness and integrity of data
Referential integrity	Ability to export NASIS data in an ASCII pipe-delimited format
Context-sensitive help on fields and tables	
A fully-integrated online help system of linked topics and robust search capabilities	

Table 1-1. NASIS Software Features

Some NASIS capabilities are specific to one of the major areas of NASIS. The NASIS map unit attributes management capabilities are shown in Table 1-2.

NASIS Map Unit Attributes Management Capabilities	
Export NASIS data into FOCS and SSURGO formats	Join map units between survey areas
Create seamless soil surveys	Produce standard soils reports
Create coordinated MLRA legends	Create specialized reports for manuscript publication
Create and edit legends, map units, and map unit data	Generate soil interpretations
Correlate map units in an ongoing survey	Create custom interpretation criteria
Maintain complete correlation records for a survey area	Access to online help topics about developing soil surveys using NASIS
Maintain multiple map unit legends	
Maintain soil survey schedules	

Table 1-2. NASIS Map Unit Attributes Management Capabilities

NASIS capabilities for managing site and point attributes are listed in Table 1-3.

NASIS Site and Point Attributes Management Capabilities	
Enter site descriptions for multiple site usages	Link pedon data to component data
Define overlaps between sites and mapunits	Accept point or spatial representations of sites
Define overlaps between sites and areas	Associate transect stops with a pedon
Enter pedon description data	Associate multiple transect stops within a transect
Record other observation data	

Table 1-3. NASIS Site and Point Attributes Management Capabilities

Outline of Essential NASIS Concepts

- In NASIS, the survey area name has been separated from the legend so that a survey area may have multiple legends.
- A single survey area may have multiple legends.
- Soil surveying progress is tracked by legend.
- The coincidence between soil survey areas and other area types can be recorded.
- Areas have been organized by area type.
- Map units have been separated into mapunits and data mapunits so that map unit symbols from different legends can be linked to the same map unit data.
- Mapunits and data mapunits are linked through a correlation table.

- Pedon, site, and site association data can be recorded for multiple pedons.
- Database security is accomplished through a concept called "owned objects" and the use of record locking and column protection.
- The role of the dataset manager is managing the assignment of users to groups. In NASIS, data is owned by a group, and users who are members of that group have authority to make changes to the data on behalf of the group.
- Some NASIS data elements are found in different tables than in SSSD. For example, hydric soil rating is in the component interpretation table.
- Flooding, ponding, soil moisture, and soil temperature are recorded by month.
- Any data element that has multiple entries has its own table. For example, unified classification has its own table because it can have more than one class.
- All water tables are now recorded as soil moisture state in the soil moisture table.
- Information about inactive map unit symbols (called "additional" symbols in NASIS) is retained in the database.
- Inclusions are "other components" in NASIS, and layers have horizon nomenclature.
- Map units can have an unlimited number of components, and components can have an unlimited number of horizons.
- You can record representative values (RVs) for some data, in addition to high and low values.
- Interpretations are generated from the actual data that represent the soil component.
- Interpretations can deal with interactions, such as the interaction of slope and water table where, as slope increases, the limitations associated with water table decrease.
- Interpretations can now deal with relative weights, such as when slope may have more importance to the interpretation than depth to water table.
- You can get a complete gradation of how true (or false) an interpretive statement is. In other words, you can use fuzzy logic to translate ranges of properties into a uniform basis.
- You are not constrained by crisp rating classes such as slight, moderate, and severe. NASIS can handle any number of rating classes.
- Because an interpretive result is a function of running the soil property data through criteria, in NASIS, interpretive results are always up-to-date with the data and criteria.
- You cannot edit interpretive results (cannot do overrides). Instead, you can edit the physical and chemical soil properties or the criteria itself. Because interpretive results are produced from data and criteria stored in NASIS, NASIS automatically documents the interpretive results.
- NASIS interpretations are for *actual* properties of the component instead of interpretations off the SIR.
- NASIS interpretations use a different set of properties converted into NASIS data elements.

NASIS Communications

NASIS communications refers to the software design, telecommunications, and network connectivity required to run NASIS at any location.

With the introduction of NASIS 5.0, NASIS data resides on a central server. NASIS Sites maintain data on the central server.

One of the requirements for a National Soil Information System is that everyone have access to nationally complete and up-to-date soils data at any time, from any location, and guarantee the integrity and security of those data. The NASIS Communication design satisfies this requirement.

About the NASIS central database

The NASIS central database is a computer that stores all the soil survey map unit data in an *Informix* database and makes it available for viewing and editing. The soils data in the central database are the “permanent” or “original” data.

The NASIS Sites

Prior to 5.0, a NASIS Site was a physical location running NASIS software. Now, NASIS software runs on a central server. Sites exist to provide logical groupings of data for ownership.

Creating and editing soil data

Soil data are created, edited, and saved to the NASIS central database and server. Users must belong to a group to create, edit, or delete NASIS data. When a soil scientist loads data for a soil survey area in NASIS, data are retrieved from the database and placed in temporary edit tables. On save, changes are made to the central database.

Running NASIS at a soil survey project office

Some soil survey project offices connect to an MO, and from there connect to the central server to run NASIS. A common scenario is a soil survey project office with an MS-DOS computer running Windows and Hummingbird connecting to an MLRA office using the LAN-WAN-Voice connection. Sites with frame relay or direct lines can connect directly to the central server. Alternatively, sites with LAN/WAN/voice dialup can connect through Kansas City.

Figure 1-1 depicts connections to the central server from the Soil Survey Project Offices (SSPO), Kansas City (KC), and MLRA Offices (MO) to NASIS Central Server at Fort Collins (FC).

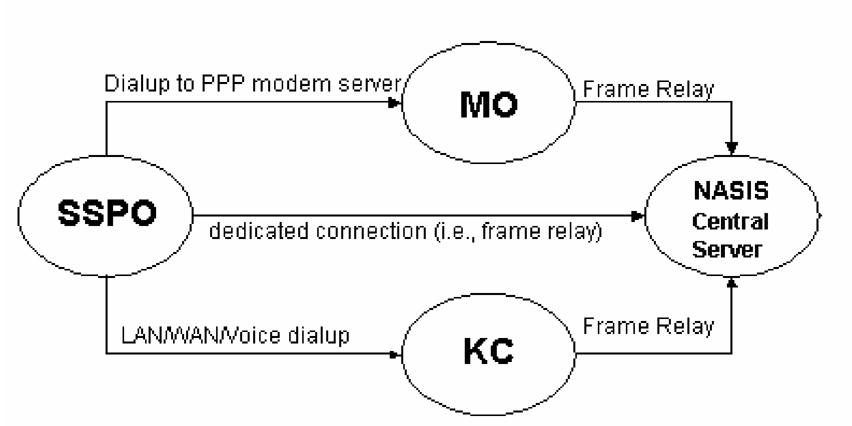

Figure 1-1. NASIS Connectivity

Objects, Ownership, and Record Locking

NASIS divides data into owned objects, including the area type, legend, data mapunit, site, pedon, site association, NASIS sites (database), geomorphic feature type, plant, ecological site, local plant, query, report, property, evaluation, rule, and edit setup objects. Each owned object is independent of the others, but may contain links to others.

An object is a record or group of hierarchically related records in the NASIS database. An owned object starts at a root table where ownership is specified and from which all other tables (in that object) are accessed. Every record in NASIS is part of an owned object. All records inherit the permissions of the owned object to which they belong. In other words, a component cannot be assigned different permissions than those of the data mapunit to which it belongs.

Data mapunits are owned objects that include all of the components for each mapunit plus all the horizons for each component in that mapunit. In Figure 1-2, DMU2 is an object owned by the correlators in the Oregon state office. Only users who are members of the Oregon state office correlator's group can edit the data mapunit, component, or horizon data for DMU 2.

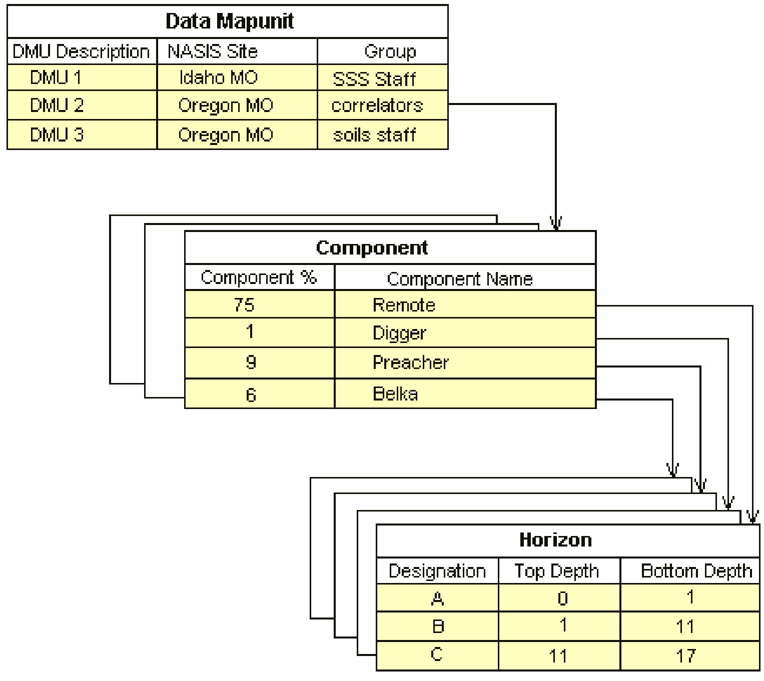

Figure 1-2. Object Ownership

What does it mean to own an object?

In NASIS, authorized users must be explicitly identified and assigned to particular groups. Data is owned by different groups, and group members have the authority to make changes to the data on behalf of the group. You may only edit objects owned by a group to which you belong. Users need no authority to *copy* an object because copying does not change the original data.

The tasks of managing users and groups are handled by the NASIS dataset manager who has the authority to edit the NASIS Site tables.

What is record locking?

Since NASIS is a multi-user system, provisions must be made to prevent two users from editing the same record at the same time. In the course of using NASIS, you may find a locked object. You cannot edit rows within a locked object. This situation typically occurs when another authorized user is currently editing or viewing the object. To maintain data integrity, NASIS prevents multiple users from altering the same data at the same time. Row status is indicated by a letter or hyphen to the left of the first column in any table. A status of ‘L’ indicates that a record is locked. You can only lock (or edit) a record if you belong to the group that owns the record. You can view records owned by other groups, but you cannot edit them. They will have a status of ‘P’, protected.

The Selected Set

In NASIS, the group of records loaded from the permanent database into temporary edit tables is called the selected set.

How the selected set is created or changed

The selected set is built using a combination of queries run via the Select Manager and records loaded using the Load Related function. These rules govern the selected set:

- When you start NASIS, the selected set is empty.
- A selected set is emptied when you exit NASIS, or when you use the *New* option on the *File* menu.
- You can load additional records into your selected set by running another query, using the Load Related function.
- Multiple queries run via the Select Manager during a single edit session are cumulative; that is, the newly selected records are appended to the selected set. Multiple Load Related actions are also cumulative within a single edit session.
- The de-select command removes one or more highlighted records from the selected set. Any unsaved edits to the de-selected records will be lost.
- You add new records by inserting rows of data.
- You can remove records from your selected set (and the permanent database) by deleting them and then saving to the database.
- The NASIS Site table is an exception—all rows are loaded the first time you view it.

Why you need to know the contents of the selected set

Some of the actions you perform on data affect the entire selected set and some affect only individual objects or rows. It is important to know what is in the selected set, because global editing functions affect records that are not presently visible on screen but are part of the selected set. Also, reports are based on the whole selected set. Only part of the selected set will be visible at any point during the edit session. For example, the query used to select data for the edit session may load only those data mapunits with a description of "015AcB." Because data mapunit is a root object, when it is loaded all of its associated components and horizons data are loaded when you perform NASIS editing functions, even though they do not appear until those tables are opened.

Target Tables

Understanding the concept of target tables—what they are and how to use them—is fundamental to selecting and editing records.

What is a target table?

Simply put, the target table focuses the outcome of a particular query. In this way, you can control the query so that it loads only the specific data you want to work on during an edit session. The target table can greatly restrict or expand the number of records returned by a particular query. To understand target tables, you must understand the relationship between objects in the NASIS database (see "Objects, Ownership, and Record Locking," page 1.7, as well as the *NASIS Technical Data Model Diagrams* and the *NASIS Database Structure* diagrams available through the NASIS home page or online help).

How target tables restrict the records returned by a query

Here's an example: In an edit session, you only want to work with mapunits that are consociations. You choose a query that loads mapunits by *kind* and specify *consociation* as the kind. Because a mapunit is part of the legend object, you could select either Mapunit or Legend as your target table. *Whether or not you load only the consociations depends on your choice of target table*.

- If you select *Mapunit* as the target table, you would load only mapunits that are consociations.
- If you select *Legend* as the target table, you would load *all* legends that have at least one mapunit that is a consociation; in addition, you would load *all* other mapunits in each of those legends.

When selecting records you will target only one table within an object. NASIS does not allow you to select more than one table in a single object.

Selecting records from different objects

Some queries are designed to select records from different database objects, for example, from the legend object and from the data mapunit object. In these cases, the query is run with multiple target tables specified.

Database Security

The ultimate goal of NASIS security is to maintain the integrity of data. NASIS security is based on a concept called "owned objects" (page 1.7).

The task of adding users is handled by the NSSC Hotline in Lincoln.

The task of managing user groups is handled by a NASIS dataset manager who has the authority to edit the NASIS Site tables. The dataset manager assigns users to groups. Unless a user is assigned to a group, the user will not have authority to edit soil data. Once assigned to a group, a user may only edit data that is owned by a group to which the user is assigned. The NASIS Security Diagram is shown in Figure 1-3.

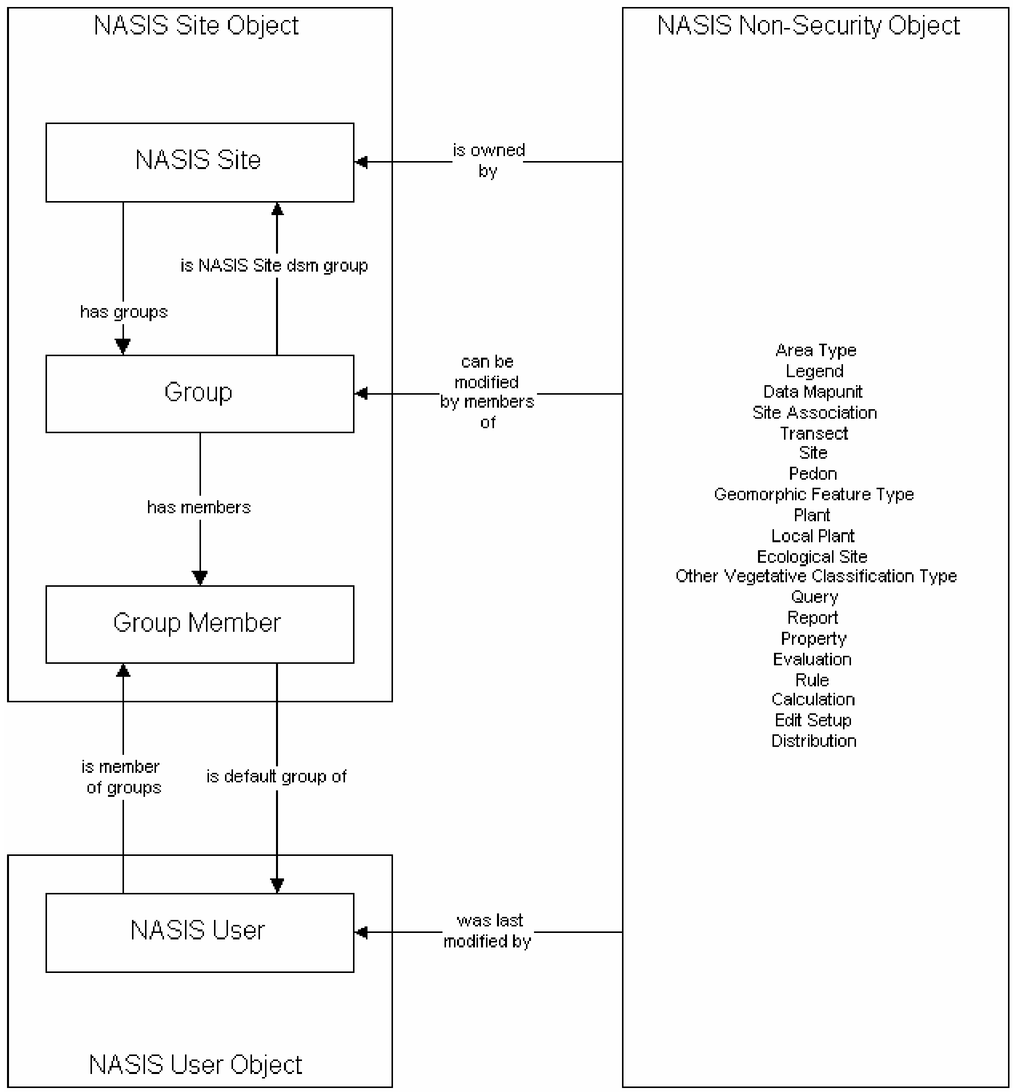

Figure 1-3. NASIS Security Diagram

The above graphic shows the relationship between the NASIS Site Object and the other owned objects. NASIS objects are owned by groups. Users are not required to belong to any group. However, a user cannot edit anything in an object unless the user belongs to a group with edit privileges for that object. Items within an object are owned by the creating group.

Certain objects, such as the Geomorphic Feature Type, Plant, and Calculation objects, contain data that are used by NASIS, but which are copied from other databases or maintained by a limited group of personnel. Most users can view these data, but cannot modify or add to the data.

Soil Survey Areas and Map Units

In NASIS, the soil survey area is separated into two parts: the *area* and the *legend*. The area includes the soil survey area name and total acres for the soil survey area. The legend includes the legend name (for example, detailed soil map legend), status, and correlation date. Legends are linked to survey areas, allowing several legends to be recorded for each soil survey area. Because there are several kinds of areas in NASIS, areas are organized by *area type* (explained in Chapter 6).

The map unit is also separated into two parts: the *mapunit* and the *data mapunit*. The mapunit includes the map unit symbol, map unit name, and correlation history. The data mapunit includes the map unit composition, physical and chemical properties. Data mapunits are linked to one or more mapunits through the *Correlation* table, allowing map unit symbols in different legends to be linked to the same data. Conversely, mapunits are linked to one or more data mapunits allowing mapunits to be correlated and conversion legends to be produced. Mapunits, Data mapunits, and the correlation table replace functions of the SOI-6 and parts of the SOI-5.

In Figure 1-4 below, the organization of NASIS tables separates the ssarea into area and legend, and separates the map unit into mapunit and data mapunit.

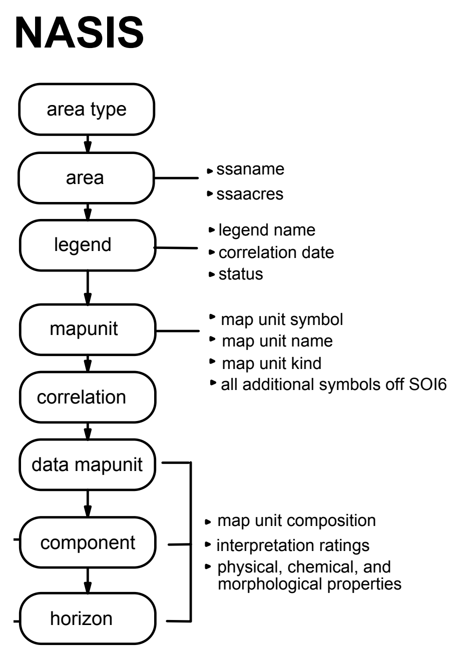

Figure 1-4. NASIS Table Organization

Multiple Legends, Coordinated Legends, and Joining Soil Survey Areas

In NASIS, a single survey area may have multiple legends. These legends could include a previous out-of-date legend and the current updated legend. In addition to multiple legends, a map unit may also be identified by symbols from different legends. These symbols could include a symbol from the soil survey area legend, a symbol from the state-wide legend, and a symbol from the MLRA legend. Each of these symbols can be different yet fully coordinated in NASIS. In effect, the map unit can have many aliases, all sharing the exact same data (or data mapunit). This capability is especially useful when joining between survey areas where two map units join exactly at the survey boundary and are identified by different symbols that are aliases for each other.

See Figure 1-5 below for an example of the joining of map units. MLRA Soil Survey Area map symbol 247A, Soil Survey Area A map symbol LiA, and Soil Survey Area B map symbol LmA are linked to data mapunit 14159. All symbols share the same mapunit data. The join between Soil Survey Area A and Soil Survey Area B is a perfect join.

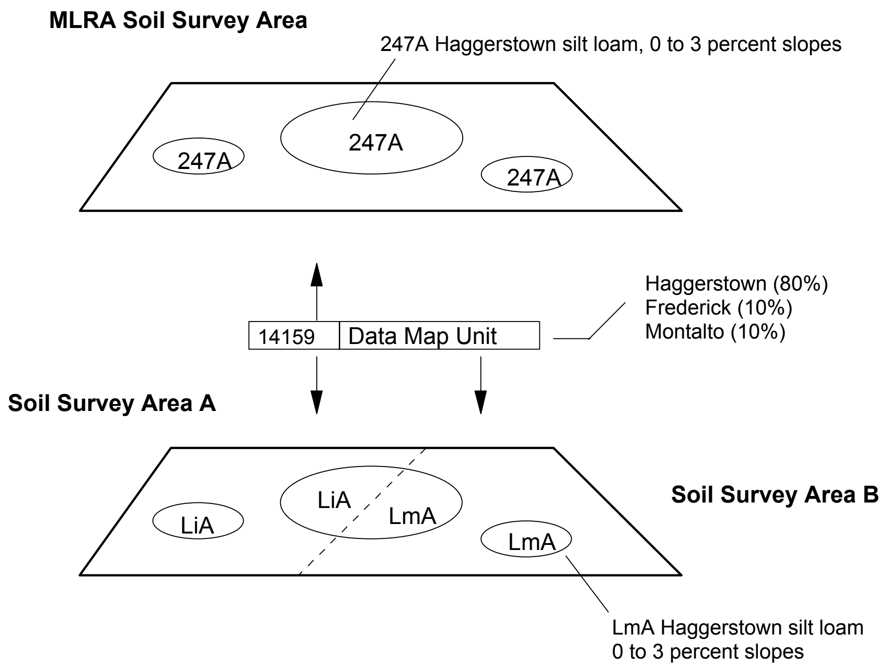

Figure 1-5. Coordinated Legends and the Joining of Soil Survey Areas

Soil Survey Goals and Progress

The Legend object in NASIS contains several data elements and tables for entering mapping goals and recording progress against those goals.

Legend and Mapunit Area Overlap

NASIS stores information about many kinds of areas including soil survey areas. These other kinds of areas, which include MLRAs, states, counties, climate factor areas, and rainfall factor areas are used to construct an “overlap” (or coincidence) with soil survey area legends and map units.

The example in Figure 1-6 shows that the Mariposa and Bell Counties Detailed Soil Map Legend is a two-county soil survey area. The legend is “overlapped” with the Bell County area to produce the Bell County Legend Overlap. This overlap records both the extent of the soil survey area in Bell County and the map units that occur in Bell County. Other overlaps could be created for MLRAs, climate factor areas, and rainfall factor areas.

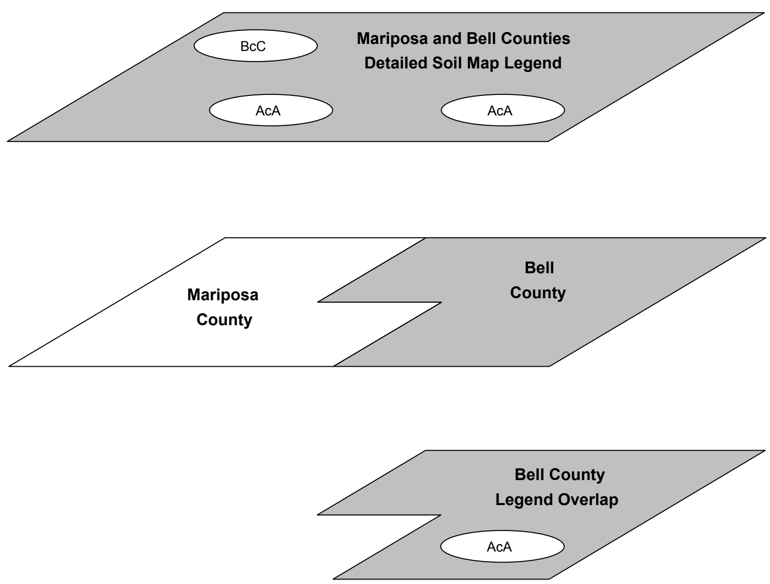

Figure 1-6. Legend and Mapunit Area Overlap

Export of NASIS Data in the SSURGO Format

NASIS provides the capability of exporting NASIS data in the SSURGO Version 2 format. Exported data is distributed in an ASCII pipe-delimited format. It can be used with common software packages such as Microsoft's *Access*.

A database template is available at http://www.nasis.nrcs.usda.gov/downloads for converting the export file into a Microsoft *Access* database. The template also contains some standard queries and reports.

The SSURGO Export selects data by legend. An export can contain data for one or more legends. Although the number of legends is not limited by the program, it is best suited to exporting a limited number (one to three), because the export process is resource-intensive. The selected legend(s) are loaded into the selected set in NASIS prior to export. The mapunits, data mapunits, and components included in the export can be selected in two ways.

Using standard criteria to identify data for export

Once the legends have been loaded into the selected set, associated mapunits, data mapunits, and components can be selected through a dialog without loading them into the selected set.

Mapunits in permanent tables are selected by status (provisional, approved, correlated, or additional). Any or all of the status types can be selected. When additional mapunits are selected, the export user can choose between the representative data mapunit to which the mapunit is correlated or the one for the additional mapunit.

Note: When exporting data for an official SSURGO export, additional mapunits are not exported. The capability to export additional mapunits exists so the users can export and review ongoing project data.

Data mapunits in permanent tables are selected by certification status (not for distribution, not certified, partly certified, or certified). Any or all of the certification status types can be selected (including data mapunits not assigned a certification status).

Components in permanent tables are selected by all components, major components, or by percent of composition.

Users can choose text kinds to be included in an export. Text kinds associated with any export data can be included.

Using the selected set to identify data for export

When the selected set is used, the mapunits, data mapunits, and components as well as the legend are loaded into the selected set. When the selected set is complete, the dialog in the NASIS export is marked to use the selected set rather than the above criteria.

(When the selected set it used, all rows in the tables are included regardless of their status. The export process does not check row status.)

Run interpretations on selected data

The export process provides the option of running interpretations on the data being exported. After criteria or selected set options are marked, the Interpretation Manager can be selected from the export dialog. National or local interpretations can be applied to the export data. Interpretation results are added to the export file. No legacy interpretations are included in the SSURGO export.

Tracking SSURGO exports in the distribution metadata object

The export writes information about the selection criteria used and the data exported into permanent tables in NASIS. The permanent tables provide an export history and reference for subsequent exports.

Export of NASIS Data into FOCS

NASIS provides the capability of exporting NASIS data into the old FOCS format. Because the data structures of NASIS and FOCS differ significantly, limited adjustments to your NASIS data may be necessary prior to downloading. If your converted SSSD data has not been edited to use structures exclusive to NASIS, it will likely pass all error and warning checks performed by the NASIS Export facility. If warnings occur, you can either make the adjustments to your data or you can continue the export by accepting default solutions specific for each warning and explained in the NASIS Online Help system. If fatal errors occur, the Export facility fails altogether, and you must intervene by making specific adjustments to your data.

NASIS uses the Sequence Number column in its data tables for defining which components to export and for differentiating between components and inclusions. A potential problem is that Sequence Numbers are used for another purpose—determining the order of components for a report. A problem can occur, because with reporting, you are not required to sequence all the records. However, when exporting to FOCS, if any of the records that you want to export are sequenced, you are required to sequence all the components to be exported. Of course, no problem exists if the order you want for components in FOCS is the same as for a report. However, you may have to make adjustments to your component sequence numbers to serve both purposes.

Table 1-2 below illustrates how you can identify which records in your NASIS Component table are exported, and of those, which three components (1, 2, 3) belong in the FOCS component table and which six components (4, 5, 6, 7, 8, 9) belong in the inclusion table.

Sequence Number	Component	Component Percentage
1	Ritzville	30
2	Charlton	20
4	Starbuck	20
3	Bakeoven	20
5	Rock outcrop	5
6	Quincy	3
7	Fluvaquents	2
8	Unnamed Saline spot	2
	Nansene	2
9	Lickskillet	1

Components start with sequence number 1 and must be consecutive

Inclusions start with sequence number 4 and must be consecutive

Sequence numbers let you define Starbuck as the first inclusion (4), even though the component percentage is the same as two other components

Table 1-4. Example of Identifying Components to Export

The FOCS export meets current user needs while limiting the impact on existing applications.

Replacing the SOI-5 and SOI-6 Forms

How interpretations were generated with SOI-5 and SOI-6

Prior to NASIS, when soil scientists needed a new soil series or phase for interpretive purposes, they would develop a Soil Interpretation Record (SOI-5) for the series or phase. They would fill in everything on the form except the interpretations to be generated. (The SOI-5 is a data entry form used for entering soil data, creating interpretations, and retrieving data.)

The project office would send the SOI-5 to Iowa State University (ISU) Statistical Laboratory at Ames, Iowa where the physical and chemical properties of a soil series or phases of a soil series were run through a Ratings program. The program would produce interpretation results. The SOI-5 data and interpretive results were stored in the soil interpretations record national database at ISU. To get soil data and interpretations for a soil map unit component, a soil scientist would submit the SOI-6 form to ISU.

The SOI-5 and the process of developing interpretations had limitations that NASIS has overcome. For example, the SOI-5 allowed only six layers. With NASIS, you can record as many horizons as necessary to describe the soil. Secondly, the previous approach would create interpretation results based on the most limiting features (or characteristics) on the SOI-5. For example, if all properties are ranked slight or moderate but one is ranked severe, the soil is given a rating of severe. In NASIS, the ranking of all properties is available.

The SOI-6 process of requesting interpretation data made it possible to delete layers and modify depths, but these modifications only changed layer tables not the stored interpretations. The SOI-5 and SOI-6 process often produced interpretations generated from different interpretation criteria. The stored SOI-5 interpretations sometimes were unrelated to the same criteria because of their vintage. Also, changes to physical and chemical properties did not automatically rerate interpretations. Additionally, some states would override generated interpretations and store these on the SOI-5. As a result, the interpretations were often inconsistent with the data. In NASIS, interpretations are made from the actual data that represent the soil component.

How NASIS generates interpretations

The SOI-5 and SOI-6 are obsolete. With NASIS, you fill in data in the component and horizon tables and then select national or local interpretive criteria through which the data is filtered. In this way, you can generate new interpretations based on current data and on calculations automatically performed by NASIS.

Previously, criteria in the Soil Interpretations Rating Guide in *the National Soil Survey Handbook* (NSSH) were applied by ISU or by hand. Through standard interpretation reports, NASIS still provides access to these old interpretations made at Ames and converted from SSSD.

Advantages of NASIS interpretation criteria

- NASIS provides interpretations for *actual* properties of the component instead of interpretations off the SIR.
- Interpretations can now deal with interactions, such as the interaction of slope and water table where, as slope increases, the limitations of the water table decrease.
- Interpretations can now deal with relative weights, such as when slope may have more importance to the interpretation than depth to water table.
- With NASIS, you can get a complete gradation of how true (or false) an interpretive statement is. In other words, you can use fuzzy logic to avoid bounding conditions where interpretive results change dramatically with only a minor change in soil properties.
- In NASIS, you are not constrained by crisp rating classes such as slight, moderate, and severe. NASIS can handle any number of rating classes.
- Because the interpretive result is a function of running the soil property data through criteria, interpretive results are always up-to-date with the data and criteria. If the data or the criteria change, the result can change.
- In NASIS, you do not edit interpretive results (interpretation overrides). Instead, you edit either the physical and chemical soil properties or the criteria itself. This allows NASIS to automatically document the interpretive result.
- NASIS lets you create local or regional interpretations based on your own criteria.
- NASIS helps you convert your property (data element) values to fuzzy numbers with a graphing tool called the Evaluation editor.
- The NASIS interpretation report gives you the ability to easily identify data voids (null or missing data).

Local Creation of Interpretation Results

In NASIS, interpretive results are generated by applying interpretive criteria to soil data. Interpretive criteria are divided into four parts: *interpretations, base rules*, *evaluations*, and *properties*.

Because interpretations, base rules, evaluations, and properties are simply data, NASIS allows you to copy and link to them to create new interpretive criteria. This makes local interpretations possible. You can create or copy and modify existing evaluations, interpretations, and base rules to meet your local needs. Properties are retrieved by complex SQL-like statements available from the NSSC Pangaea site. Because of their complexity, it is unlikely that you will edit or create properties. Instead, you will likely choose existing ones from a choice list.

Overview of interpretation criteria

An *interpretation* is a type of rule in NASIS. It is a logical statement about land use, limiting features, and the relationship among limiting features. Interpretations are stored in the Rule table. The land use is identified as the Rule Name, and the interpretation's limiting features and the relationship among them (relative weights and interactions) are depicted graphically with a special Rule Editor.

A *base rule* is a logical statement about one limiting feature. A base rule says nothing about the land use; therefore, the same base rule can be used in building different interpretations. Base rules are aggregated into an interpretation and are considered the basis, or building blocks, of an interpretation. Like interpretations, base rules are stored in the Rule table. The limiting feature is stored as the Rule Name. A naming guideline helps you distinguish base rules from interpretations.

Base rules have at least one evaluation linked to them. The linked evaluation(s) are depicted graphically in the Rule Editor. In order to report interpretive results, an evaluation must be linked to a base rule. The base rule gives you the flexibility of reusing evaluations for different interpretations.

An *evaluation* is an assessment of a particular soil property for its relative impact as a limiting feature. Using the principles of fuzzy logic (fully explained in Chapter 15), you can graph the impact of a limiting feature in an Evaluation Editor. The graph helps you evaluate the soil property and its relative truthfulness as a limiting feature. For example, if a soil percs absolutely too slowly, the fuzzy value would be 1. If it percs absolutely not too slowly, the fuzzy value would be 0. Fuzzy logic allows you to evaluate the property when it falls in the range between absolutely too slowly (1) and absolutely not too slowly (0). For example, if the soil percs moderately slowly, you might plot it as 0.5, meaning that the soil has a 0.5 truthfulness of percolating absolutely too slowly.

An evaluation is the relationship between the property and its impact on the interpretive application. Evaluations specify the ranges used to assess the relative truthfulness of a statement about a soil property. For example, the evaluation criteria set the limits for determining whether the statements "soil percs too slowly" and "soil filters too poorly" are absolutely not true, absolutely true, or somewhere in between.

Fuzzy logic allows you to deal with relative statements about soil properties. For example, in a traditional view, the logical statement A AND B means that both A and B must be absolutely true for the statement to be true. However, with fuzzy logic, each of

A and B represent some degree of truthfulness, from absolutely *not* true to absolutely true. The statement A AND B evaluates the minimum truthfulness for either of A and B. Thus, if a soil must be deep and dry in March to be suitable for early tillage, and the soil is deep but moist, the statement that the soil is deep is true but the statement that the soil is dry is only partly true. Therefore, the soil is partly suited to early tillage.

This statement about soil behavior can be articulated in terms of relative truthfulness. If the soil is very nearly dry then its degree of truthfulness is very nearly 1 (perhaps 0.9) and it is very nearly suited (0.9) to early tillage. The degree of truthfulness is numerical and can be used in mathematical operations or converted into classes such as slight, moderate, and severe. Regardless of how it's used, fuzzy logic allows you to deal with relative statements about soil properties and make more intuitive, more precise, and more useful interpretations. Refer to Chapter 14 for a full discussion of fuzzy logic.

A *property* is the specified soil data retrieved from the soil database. The term *property* can sometimes refer to the SQL-like statement that retrieves the soil data. Properties are stored in the Property table.

Relationship to the previous system

Although the names are new and the capabilities are different, soil scientists have been using the concept of interpretation/base rule/evaluation/property to make interpretations for many years. In the *National Soil Survey Handbook* (NSSH), interpretive criteria are typically represented in table form as shown in Tables 1-5 through 1-7.

The shaded areas in Table 1-5 represent an interpretation with two base rules which state that the limitation for septic tank absorption fields is based on percolation *or* filter fields between the depths of 24-60 inches. (Of course, there are several other restrictive features for septic tank absorption fields. For this example, however, we use only two.)

Septic Tank Absorption Fields				
property	slight inches/hour (μm/sec)	moderate inches/hour (μm/sec)	severe inches/hour (μm/sec)	restrictive feature (base rule)
permeability minimum in depth 24-60"	2.0-6.0 (14-42)	0.6-2.0 (4-14)	< 0.6 (<4)	percs slowly (percolation)
permeability maximum in depth 24-60"	-	-	> 6.0 (42)	poor filter (filter fields)

Table 1-5. Tabular Depiction of an Interpretation and Base Rules

The shaded area in Table 1-6 contains the evaluation criteria. The criteria sets the limits for determining whether the evaluative statements “soil percs too slowly” and “soil is a poor filter” are absolutely not true, absolutely true, or somewhere in between. The criteria for the evaluation are in the shaded area. Evaluation criteria specify the ranges used to assess the relative truthfulness of a statement about a soil property.

Septic Tank Absorption Fields				
property	slight inches/hour (μm/sec)	moderate inches/hour (μm/sec)	severe inches/hour (μm/sec)	restrictive feature (base rule)
permeability minimum in depth 24-60”	2.0-6.0 (14-42)	0.6-2.0 (4-14)	< 0.6 (<4)	percs slowly (percolation)
permeability maximum in depth 24-60”	-	-	> 6.0 (42)	poor filter (filter fields)

Table 1-6. Tabular Depiction of an Evaluation

The shaded area in Table 1-7 lists the properties being evaluated. These properties are values that can be retrieved directly from the database or calculated (derived) from values that are in the database.

Septic Tank Absorption Fields				
property	slight inches/inch (μm/sec)	moderate inches/inch (μm/sec)	severe inches/inch (μm/sec)	restrictive feature (base rule)
permeability minimum in depth 24-60”	2.0-6.0 (14-42)	0.6-2.0 (4-14)	< 0.6 (<4)	percs slowly (percolation)
permeability maximum in depth 24-60”	-	-	> 6.0 (42)	poor filter (filter fields)

Table 1-7. Tabular Depiction of a Property

Ownership of interpretations, rules, evaluations, and properties

Interpretations, base rules, evaluations, and properties are owned objects in NASIS. They are data and have ownership associated with them, as do queries and reports and any other NASIS object. Therefore, you can copy, look at, and link to any interpretation, base rule, evaluation, or property, but you can edit only those that you own.

Whether you are using locally or nationally created interpretive criteria, when you choose and interpretive report and run it, the soils data in your selected set is applied to the criteria to derive interpretation results.

Interpretation results

NASIS allows you to report interpretive results. Standard report formats are available. You can also customize the report scripts to adjust interpretations or report formats.

If interpretive results do not reflect known behavior, either the soil data is incorrect or the interpretive criteria are inadequate. If the soil data accurately reflect soil conditions observed in the field and yet the interpretive results do not reflect known behavior, the interpretive criteria must be inadequate. You can adjust interpretive results by adjusting the interpretive criteria, the soil data, or both.

Summary of interpretive criteria

In summary, properties, evaluations, base rules, and interpretations work together to form the interpretive criteria. Properties are retrieved from the database, evaluated according to the criteria's truth or membership function, and used in interpretations to make statements about the property's effect on the specific interpretative application.

Figure 1-7 is intended to provide a high level view of interpretive criteria. Keep in mind that it is not the process flow you would use when creating interpretive criteria.

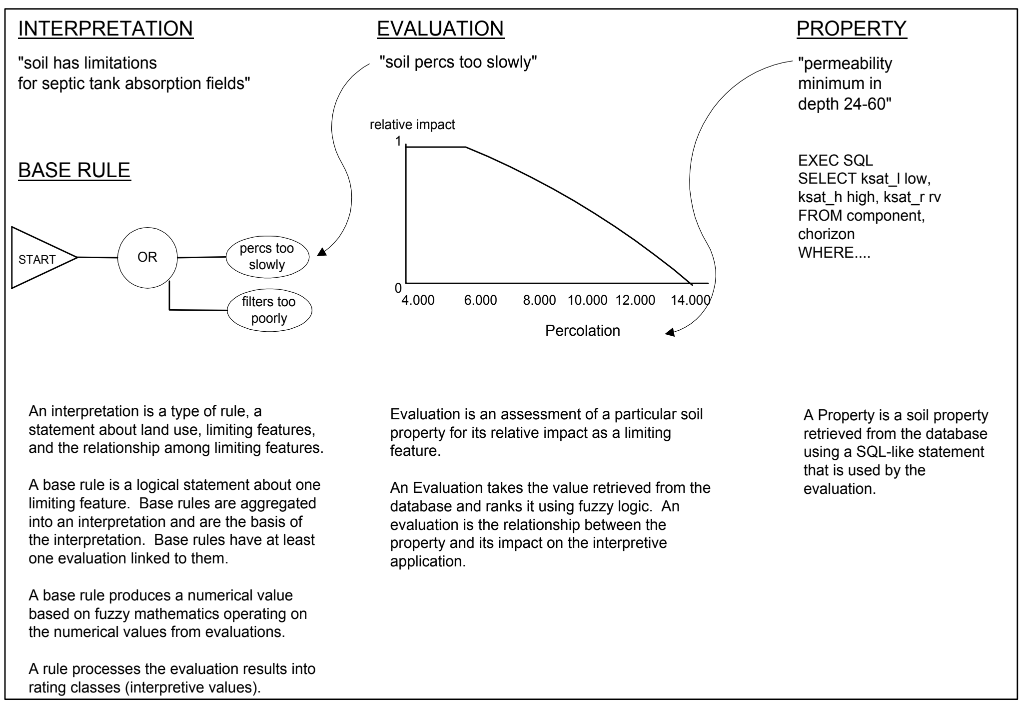

Figure 1-7. A Graphical View of Interpretive Criteria

For simplicity, Figure 1-7 shows an evaluation for percolation only. To evaluate percolation, you decide that a soil percs definitely too slowly if it percs at less than 0.6 inches per hour (4 micrometers/second). It percs definitely not too slowly if it percs at more than 2.0 inches per hour (14 micrometers/second). Thus, for any given soil, you can assess (*evaluate*) the relative truthfulness of the statement “soil percs too slowly.” Finally, the property being evaluated is minimum permeability values for horizons in a depth of 24-60” (60-150cm). This value is retrieved from the database using a query-like statement.

Figure 1-8 below is an illustration summarizing the relationship between interpretations (including base rules), evaluations, and properties. Using an interpretation for septic tank absorption fields you say a soil has limitations for septic tank absorption fields if the soil percs too slowly or filters too poorly.

Figure 1-8 also illustrates that base rules focus on one limiting feature and must link to at least one evaluation. Base rules say nothing about the land use; therefore, you can use them in different interpretations. Base rules are aggregated into an interpretation and considered the basis, or building blocks, of an interpretation

Chapters 14 through 16 discuss understanding, reporting and developing interpretive criteria in detail.

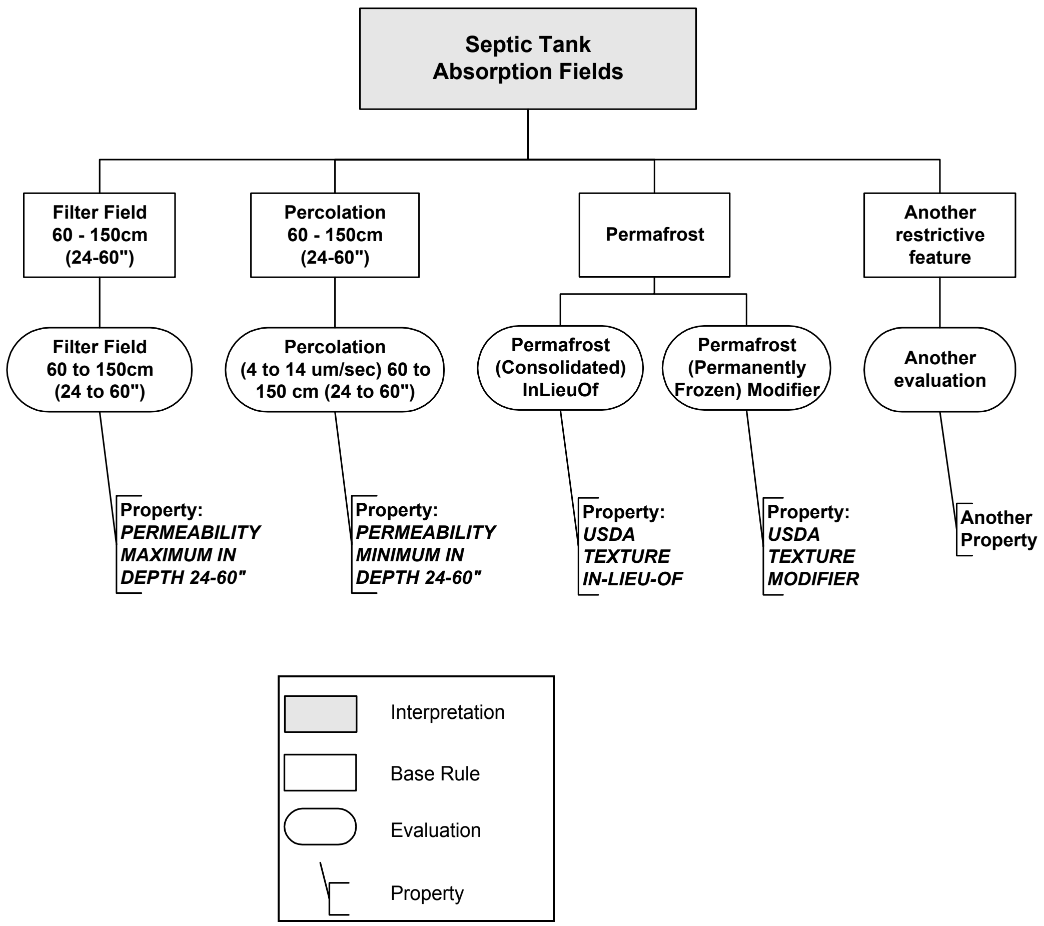

Figure 1-8. Relationships Among Interpretive Criteria

Site and Point Attributes in NASIS

Site and point attributes represent the second major area of NASIS. NASIS contains four objects for managing site and point attributes data. The Site, Pedon, Transect, and Site Association objects each contain several tables. These tables allow entry and maintenance of site description, soil profile descriptions, and the relationship between sites, such as satellite samples, and the relationship between pedons, such as transects.

As with any objects in NASIS, the site, pedon, transect and site association objects are independent. Links between these objects and to objects within the other major areas of NASIS can be established.

Comparison to PEDON Description Program 3.x

NASIS offers much of the same functionality provided by the PEDON Description Program, except that it uses the standard NASIS editing tools and interface. NASIS tools allow more flexible querying and reporting of site and point data and provide new capabilities to accurately record redoximorphic features, landforms, and other soil characterizations.

Comparison between NASIS and PEDON Description Program 3.x	
PEDON Description Program 3.x	**NASIS**
• Enter site and horizon data in site and horizon screens	• Use tables in the site object to enter locational information that remains constant for several observations and associate the information with individual observations at the site • Use pedon tables to record profile descriptions, pedon horizon details, and transect stops.
• Select pedon data using Chooser screen and edit the data using site and horizon screens	• Build a selected set including the pedon to edit and use standard NASIS editing tools
• Report data using Chooser and predefined reports	• Build a selected set and use or create report scripts in NASIS or create your own reports
• Transfer pedons	• Pedons entered by any group may be viewed and linked to by other NASIS sites. Change ownership allows transfer of editing responsibilities to another group.
• Access popups for multiline entries	• Enter properties that may have multiple entries on separate tables
• Enter horizons with two distinct parts	• Enter horizons with two distinct parts twice; once for each horizon
• Define a transect	• Create a transect between multiple pedons and sites involved in a transect • Associate a specific observation date and ID with a transect stop through the pedon table.
• No direct connection to NASIS	• Ability to define overlaps between sites and areas and associate pedons with components

Table 1-8. Comparison between NASIS and PEDON Description Program 3.x